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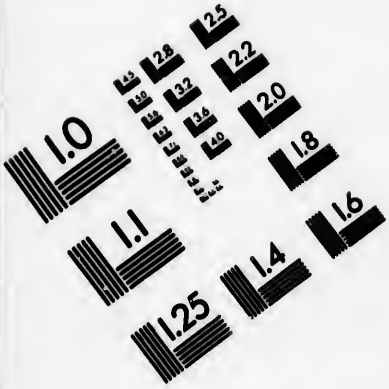

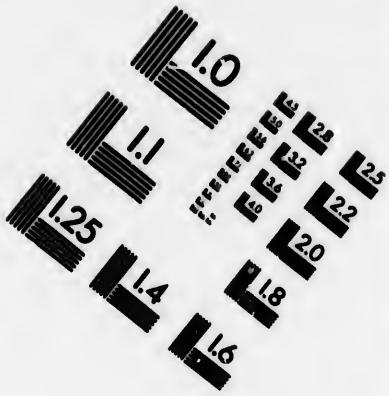

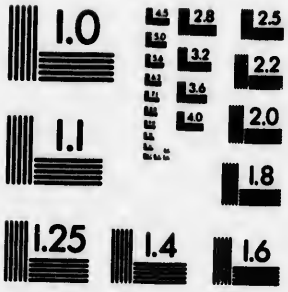

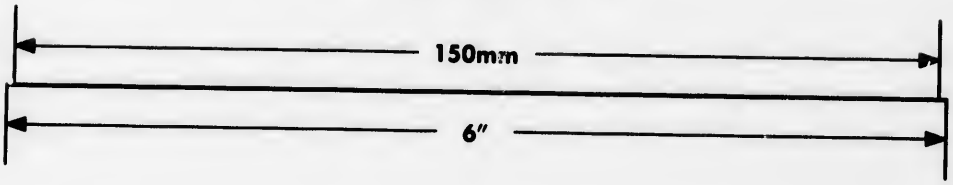

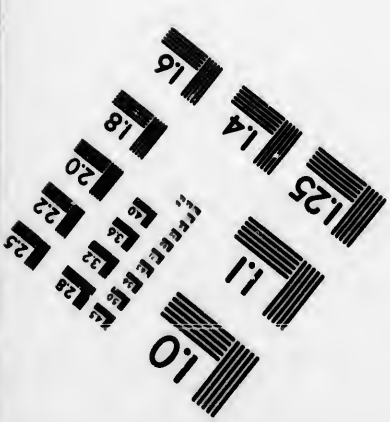

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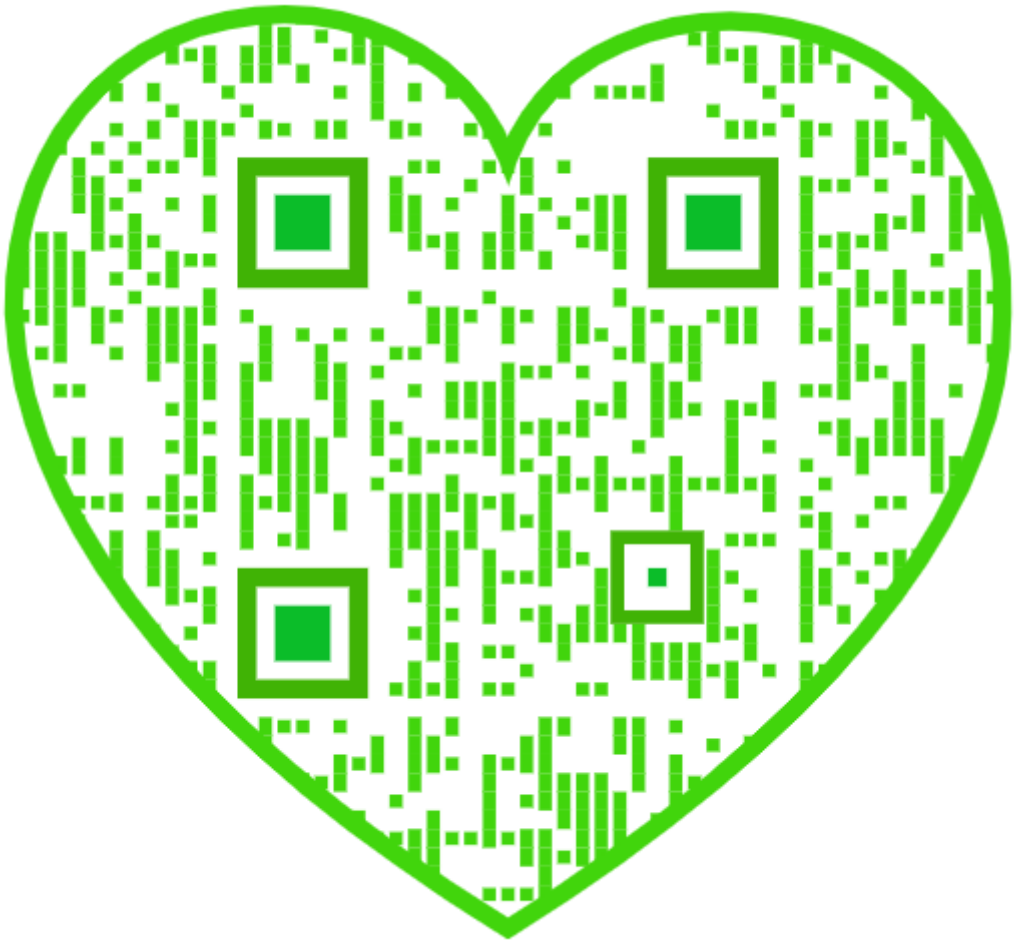

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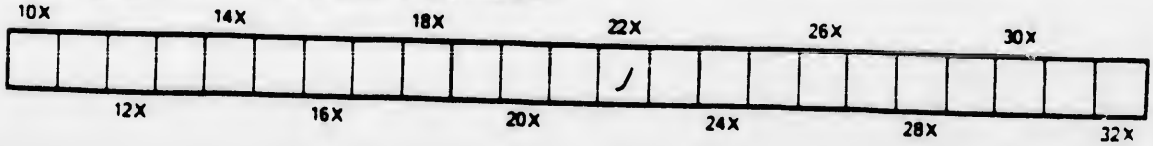

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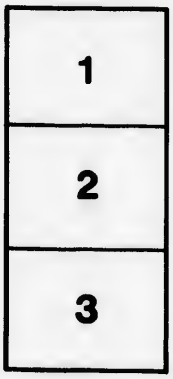

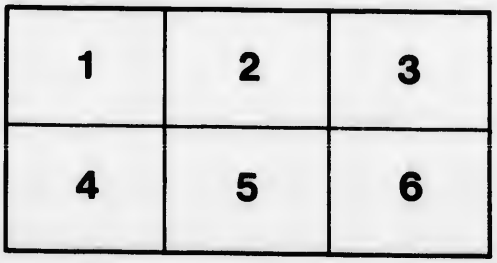

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BULLETIN 102. MAY, 1896.

Ontario Agricultural College and Experimental Farm

EXPERIMENTS IN CHEESEMAKING:

By H. H. Dean, B.S.A., Professor of Dairy Husbandry.

PART I. Relation of Fat in Milk to Quantity and Quality of Cheese Produced in the Months of November and December, 1895

PART II. Summary of Two Years' Work on the Relation of Fat in Milk to Cheese Produced.

PART III. Effects of Salt, Temperature, Rennet, and Acid in Cheese-Making.

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AND

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BULLETIN 102.

EXPERIMENTS IN CHEESE-MAKING.

PART I.

RELATION OF FAT IN MILK TO QUANTITY AND QUALITY OF CHEESE IN THE MONTHS OF NOVEMBER AND DECEMBER, 1895.

The cheese made from milk with different percentages of fat during the months of November and December, 1895, were not ripened sufficiently to be scored at the time for preparing our Annual College report: so the results for these two months, together with a summary of two years' work on the question of the relation of fat in milk to the quantity and quality of cheese produced, is submitted for the information of dairymen.

Conditions of Manufacture in November and December.

The quantity of milk in each vat was 300 lbs. The percentage of fat in the milk of the different vats during the two months varied from 3. to 5.50 per cent. The average temperature at which the milk was set was 86°F. The rennet test for ripeness was about eighteen seconds. The rate of rennet per 1,000 pounds of milk was three and one-third ounces. The cooking temperature for rich milk curd was 100°, and for the poorer curds 98°. In one experiment, on Dec. 30th, in which the milk tested 5.0 per cent. fat, it was set at 81°; and after cutting, it was gradually cooked to 100°, two hours having been spent in the process. The loss of fat in the whey was .5 per cent. The curd in this experiment was salted at the rate of three and a half pounds of salt per 100 pounds of curd. This method of handling did not prevent the cheese from being "sticky," "greasy," or "slippery."

The curds when dipped showed about one-quarter of an inch of string on the hot iron. The average time from setting to dipping was about three hours, and the the time from dipping to salting was about three and a half hours. The curd from rich milk was nearly always ready to salt first. The amount of salt used was from two and three-quarters to three and a quarter pounds per 100 pounds curd. The larger quantity was used on the curds from richer milk. The length of time for pressing the cheese was about twenty-one hours, in a gang press. The temperature of the curing room was

from 65° to 70°. The moisture in the curing room was "normal," as indicated by the Hygrometer.

The tables show the percentage of fat in the milk on the different dates, the pounds of fat, the pounds of cheese produced, the ratio of cheese to milk and fat, and the loss of fat in the whey, as determined by the Babcock tester.

NOVEMBER.

Relation of fat in milk to quantity and quality of cheese :

Date.	Per cent. fat in milk.	Lbs. fat in milk.	Lbs. cheese.		Lbs. milk to 1 lb. cheese.		Lbs. cheese to 1 lb. fat in milk.		Per cent. fat in whey.
			Green	Cured	Green	Cured	Green	Cured	
1895.									
November 5	3.90	11.70	33.25	31.75	.....	....	.....	.....	.30
	3.60	10.80	30.50	29.25	....	.....	.....	.....	.20
" 6	4.00	12.00	33.50	32.00	.....	....	.....	.....	.35
	3.30	9.90	29.50	28.00	...	....	.....	.....	.20
" 14	3.85	11.55	33.75	32.25	.....	.....	.....	.....	.20
	3.55	10.65	31.75	30.50	.....	.....	..	.....	.20
" 15	3.90	11.70	33.25	31.75	. . ..	.....	.....	.....	.20
	3.30	9.90	30.25	28.75	.....	.....	.....	.....	.20
" 21	4.00	12.00	33.50	32.00	.....	.....	.....	.....	.20
	3.50	10.50	31.50	29.75	.....	...	.....	....	.15
" 22	4.00	12.00	35.00	33.25	.....	.....	.....	.....	.20
	3.57	10.65	31.25	29.50	.....	.....	.....	.....	.20
" 28	4.10	12.30	35.50	34.25	.....	.....	.....	.....	.20
	3.80	11.40	32.50	31.25	.....	.....	.....	.....	.20
" 29	4.00	12.00	35.00	33.50	.....	.. ...	.....	.....	.20
	3.50	10.50	30 00	28.75	.....	.....	.....	.....	.20
Average for rich milk	3.97	95.25	272.75	260.75	8.79	9.20	2.86	2.73	.23
Average for poor milk	3.51	84.30	247.25	235.75	9.70	10.17	2.83	2.76	.19

The experiments for these two months agree with the results already published. The yield of cheese per 100 lbs. of milk was greater from the milk rich in butter-fat, but it was not in proportion to the butter-fat. Three hundred pounds of milk, testing 5.0 per cent. of butter-fat, produced 34.5 lbs. cheese, while on the same day 300 lbs. of 3.0 per cent. milk produced but 26.5 lbs. of cured cheese, a difference of 8 lbs. of cheese in 300 lbs. of milk. But the ratio of cheese to fat in the milk was 2.30 for the 5.0 per cent. milk, and 2.94 for the three per cent. milk. The ratio of cheese to fat in the milk testing 5.5 per cent. was 2.27. In a vat of milk testing 4 75 per cent. fat, the ratio was 2.38.

December.

Relation of fat in milk to quantity and quality of cheese:

Date.	Per cent. fat in milk.	Lbs. fat in milk.	Lbs. cheese.		Lbs. milk to 1 lb. cheese.		Lbs. cheese to 1 lb. fat in milk.		Per cent. fat in whey.
			Green	Cured	Green	Cured	Green	Cured	
1895.									
December 5....	4.00	12.00	34.75	33.25	.....	.....	....	....	.20
	3.40	10.20	30.25	29.00	.....	.....	.....	.....	.20
" 6....	4.10	12.30	35.25	34.00	.....	.....	.....	.....	.22
	3.40	10.20	30.50	29.00	.....	.....	.....	.....	.20
" 12....	3.90	11.70	35.25	33.50	.....	.....	.....	.....	.18
	3.30	9.90	31.00	29.50	.....	.....	.....	.....	.18
" 13....	4.00	12.00	34.50	33.00	.....	.....	.....	....	.20
	3.15	9.45	29.50	28.00	....	.....	.....	.....	.20
" 20....	4.75	14.25	35.25	34.00	.....	.....	.....	.....	.30
	3.25	9.75	28.25	26.75	.....	.....	.....	.....	.15
" 21....	5.50	16.50	39.25	37.50	.....	.....	.....	.....	.45
	3.20	9.60	28.50	26.50	.....	.....	.....	.....	.20
" 23....	4.40	13.20	35.50	33.75	.....	.....	.....	.....	.25
	3.10	9.30	28.50	26.75	.....	.....	.. .	.....	.15
" 28 ...	5.10	15.30	37.25	35.50	.....	.....	.....	.....	.40
	3.00	9.00	28.50	26.75	.....	.....	.....	.....	.20
" 30....	5.00	15.00	35.75	34 50	.....	.....	.....	.....	.50
	3.00	9.00	28.50	26.50	.....	. ...	.....	.....	.40
Average for rich milk	4.53	123.25	322.75	309.00	8.36	8.73	2.64	2.52	.30
Average for poor milk	3.20	86.40	263.50	249.25	10.24	10.82	3.05	2 85	.21

It will be noticed that the per cent. of fat in the whey was slightly higher from the rich milk, as compared with the poorer. This agrees with the results of our previous experiments.

The percentage of loss in weight at the end of one month was 4.4 for the rich milk cheese in November, and 4 6 for the poorer milk cheese. In December, the loss was respectively 4.2 and 5 3 per cent. As stated in the Report for 1895, this difference in loss of weight while the cheese are curing, is likely due to the fact that more surface is exposed per 100 lbs. of cheese in the case of the poorer milk cheese.

Scoring of the November and December Cheese.

The cheese made from milk containing different percentages of fat in the months of November and December, were scored at four different times (with a few exceptions) by the following gentlemen on the dates given:

The November cheese were judged by Messrs. Geo. Brill and T. B. Millar, on January 4th, 1896. These cheese, together with the December cheese, were again scored by Mr. R. M. Ballantyne, on Feb. 21st, 1896, by Mr. A. F. MacLaren on March 6th, and by the two latter gentlemen together, on April 7th.

Table showing the score of cheese made from milk containing different percentages of fat:

Date when cheese were made	Per cent. of fat in milk.	Scoring of judges. Maximum—100.					
		A. T. Bell.	T. B. Millar and Geo. Brill.	R. M. Ballantyne.	A. F. McLaren.	McLaren and Ballantyne.	Average
Dec. 28...	3.00	90	.....	91	81	90	88
30...	3.00	89	.....	92	89.5	88	89.6
23...	3.10	92	.....	94	92	90	92
13...	3.15	84	.....	95	88	91	89.5
21...	3.20	91	.....	93	89	91	91
20...	3.25	92	.....	97	94.5	94	94.3
Nov. 15...	3.30	.....	91	95	86	92	91
Dec. 12...	3.30	91	.....	97	90	88	91.5
Nov. 6...	3.40	.....	90	89	90.5	.....	89.8
Dec. 5...	3.40	89	.....	92	91.5	92	91.1
6...	3.40	93	.....	93	95	92.5	93.3
Nov. 21...	3.50	.....	95	94	93.5	87	92.3
29...	3.50	.....	94	.....	.....	.....	94
14...	3.55	.....	91	.....	.....	.....	91
22...	3.55	.....	91	95	90	93	92.2
5...	3.60	.....	85	80	80	82	81.7
28...	3.80	.....	93	93	92.5	91	92.3
14...	3.85	.....	95	.....	.....	.....	95
5...	3.90	.....	90	87	88.5	.....	88.5
15...	3.90	.....	93	94	93	89	92.2
Dec. 12..	3.90	91	.....	94	92	90	91.7
Nov. 6...	4.00	.....	92	84	89	85	87.5
21...	4.00	.....	96	96	93	96	95.2
22...	4.00	.....	94	97	91.5	93	93.8
29...	4.00	.....	95	.....	.....	.....	95
Dec. 5...	4.00	91	.....	92	91	90	91
13...	4.00	93	.....	97	92	92	93.5
Nov. 28...	4.10	.....	92	94	90	90	91.5
Dec. 6...	4.10	91	.....	96	93	92	93
23...	4.40	89	.....	92	95	86	90.5
20...	4.75	92	.....	95	91	94	93.7
30...	5.00	91	.....	96	93.5	93	93.3
23...	5.10	93	.....	95	91	90	92.2
21...	5.50	90	.....	95	89	.....	91.3

The December cheese were first scored by Mr. A. T. Bell on February 17th, 1896; and then by Messrs. Ballantyne and MacLaren on the dates given for the November.

The table shows the score given for each cheese (arranged in the order of the percentages of fat in the milk) by each judge, or judges, and the average of all scores. They used the following scale of points: Flavor, 35; closeness, 20; even color, 15; texture, 20; finish, 10 (all cheese scored 10 points for finish); total, 100.

The table shows that the cheese scoring the highest average, 95.2 points, was made on November 21st, out of milk testing 4.0 per cent. of butter fat. The second highest scoring cheese was made on December 20th, out of milk testing 3.35 per cent. fat. This cheese scored an average of 94.3 points out of 100. The highest number of points given to a cheese by one judge at one scoring, was ninety-seven. The cheese scoring ninety-seven points were made out of 3.25, 3.30, and 4.0 per cent. milk on December 20th, November 15th, November 22nd, and December 13th, four cheese in all. These scores were all given by Mr. R. M. Ballantyne, on February 21st. Cheese scoring ninety-six points were made from milk testing 4.0, 4.1, and 5.0 per cent. milk Cheese scoring ninety-five points, were made from 3 15, 3.30, 3.40, 3.50, 3.55, 3,84, 4.0, 4.40, 4.75, 5.10, and 5.50 per cent. milk.

The two cheese made in one day which scored the highest average (four scorings), were made on December 20th out of 3.25 and 4 75 per cent. milk. It will be noticed that these two cheese were scored uniformly high by all the judges. The next highest scoring pair were made on November 21st out of 3.50 and 4.0 per cent. milk. Both cheese scored uniformly high in all the tests, except in the case of the cheese made out of 3.5 per cent. milk, which was scored down to eighty-seven points by Messrs. Ballantyne and MacLaren on April 7th. It scored low in flavor and texture. The table of scorings by these gentlemen has a number of interesting points, besides the lesson of values as indicated by the scoring. It shows among other things, the difference in the opinions of different judges as to the value of a cheese. To illustrate: the cheese made December 13th, out of 3.15 per cent. milk, was scored eighty-four points by Mr. Bell on February 17th. On February 21st (four days later), Mr. Ballantyne scored this cheese ninety-five points. On March 6th (fourteen days later), Mr. MacLaren scored this same cheese eighty-eight points; and on April 7th, Messrs. MacLaren and Ballantyne scoring together, gave this cheese ninety-one points. A cheese made out of 3.3 per cent. milk on Nov. 15th, was scored ninety-five points by Mr. Ballantyne, eighty-six points by Mr. MacLaren, and ninety-two points by these two gentlemen a month later. While a cheese will no doubt, in two weeks or a month, undergo changes which will affect its scoring, we can scarcely conceive of a

cheese changing from a ninety-five point to an eighty-six point cheese in two weeks, and then back to a ninety-two point cheese in four weeks' time. Evidently the different tastes, or judgments, of the persons scoring a cheese, are an important factor in determining its quality. It will be noticed, however, that, on the whole, the scorings were fairly uniform as to points given.

In the following table, the cheese made from milk ranging from 3.0 to 3.5 per cent. of fat have been grouped together, and the average scores in qualities (flavor, closeness, even color, and texture) are given. Most of the cheese were scored four times, and the average in each quality represents the average of all the scores of each cheese in a group, together with the average total score of all the cheese for the group. The cheese made from 3.55 to 4.0 per cent. milk are grouped together; also those from 4.05 to 4.50; those from 4.55 to 5.0; and those from 5.05 to 5.50, making five groups in the November and December cheese. In making these average score of qualities, a few of the cheese whose scores are recorded in the previous table, are left out, as they developed such a very bad flavor before the final scoring, that it would be unfair to group them with the others in making an average. Sometimes a very bad flavor will develop in a cheese, which it is difficult to account for. The number of cheese made out of milk testing over 4.0 per cent. of fat is too small to draw definite conclusions from them.

Table showing the average score of qualities in cheese made from milk containing different percentages of fat:

No. of cheese in group.	Average per cent. fat in milk	Average score.				
		Flavor—max. 35.	Closeness—max. 26.	Even color—max. 15.	Texture—max. 20.	Total—max. 90.
13.....	3.26	30.91	18.43	14.15	18.03	81.52
11.....	3.87	31.26	18.80	14.40	18.46	82,92
3.....	4.20	30.60	18.70	13.86	18.03	81.19
2.....	4.87	32.15	19.00	14.15	18 05	83 35
2.....	5.30	31.75	18.90	13.80	17.25	81.70
Averages ..	3.82	31.33	18.76	14.07	17.96	82.13

Of the cheese scored four times, the one which scored the highest average in flavor, was made December 30th, out of 5.0 per cent. milk. The average score was 32.6 out of thirty-five. It was scored 32 twice, 32 5 once, and 34 once The average score of this cheese in other qualities, was 18.8 for closeness, 14 for even color, and 17.8 for texture. The lowest average score (one cheese) in flavor, was one made out of milk testing 3.8 per cent. fat, on November 28th.

The score was 29.9 out of a possible 35. The remainder of the score was 18.8 for closeness, 14.3 for even color, and 18.6 for texture, which is higher in these qualities than the cheese which scored highest in flavor. Good flavor is not always found in a close, even-colored cheese, of good texture, nor are these qualities always found in a cheese with good flavor.

The highest average score for "closeness" was 19.2 points out of a possible 20. The cheese averaging this score were made out of 3 25, 3.50, and 4.75 per cent. milk, on December 20th and November 21st. The lowest average score for "closeness" was a cheese made out of milk testing 3.15 per cent. fat. The score was 16.5. The highest average score for "even color" was 14.7 out of a possible 15. This cheese was made out of 4.0 per cent. milk, on November 21st. Several cheese scored 14.5 points in color. The lowest score in "even color" was 13 points. The cheese was made out of 3 00 per cent. milk. A cheese made December 23rd, out of 4.4 per cent. milk, scored an average of 13.1 points. The highest average score in "texture" was 19.2 out of 20. This cheese was made November 21st, out of 4.0 per cent. milk. A cheese made December 6th, out of 3.4 per cent. milk, scored 19.1 points in texture; and several averaged 19 points.

The cheese scoring lowest in "texture" was one made on December 23rd, out of 4 4 per cent. milk. The score was 16.7. This cheese was also lowest in "color." The next lowest in "texture" was a cheese made from 5.5 per cent. milk, on December 21st. The "texture" was described by the experts as "greasy" and "slippery." The average score was seventeen. Once it was scored sixteen points.

Table showing the amounts of money that would be credited to H. and L. milk for the months of November and December, when reckoned according to the different methods, and according to the weight of cheese.

Month.	Lbs. milk.	Average per cent. fat in whole milk.	Lbs. cured cheese made.	Reckoning cheese at 8c. per lb., each lot would be credited with the following amounts of money when paid according to:			
				Weight of milk.	per cent. of fat.	per cent. of fat + two.	Weight of cheese.
				$ c.	$ c.	$ c.	$ c.
November ...	2,400 H	3.97	260.75	19 86	21 07	20 65	20 86
	2,400 L	3.51	235.75	19 86	18 65	19 06	18 86
December	2,700 H	4.53	309.00	22 33	26 17	24 86	24 72
	2,700 L	3.20	249.25	22 33	18 49	19 80	19 94

PART II.

Summary of Cheese Experiments relating to Medium, Rich, and Poor Milk, for the Years 1894 and 1895.

During these two years we have manufactured into cheese 287 vats of milk, averaging 300 pounds each, or 86,100 pounds altogether, in studying the problems connected with the question of the relation fat in milk to the quantity and quality of cheese made. A summary of these results is now given. In addition to the experiments herein summarized, there were over 100 experiments made during 1895, to determine the effects of different cooking temperatures and different quantities of salt on curds from medium, rich, and poor milk. These were fully outlined in the College Report for 1895. The experiments relating to these two points may be summarized by saying that curds from poor milk (below 3.25 per cent. fat) should be salted more lightly than average curds, to overcome the tendency to harshness, while curds from rich milk (4.0 per cent. fat and over) may be cooked one or two degrees higher than usual and be salted somewhat more heavily than average curds, in order to overcome the tendency to "pastiness" in cheese made from rich milk.

The experiments relate chiefly to the following points:

1. The relation of weight or volume of milk to the *quantity* of cheese produced.

2. The relation of the fat in milk containing different percentages of fat, to the amount of cheese produced.

3. The relation of the fat and casein in milk containing different percentages of fat, to the cheese produced.

4. The relation of the loss of fat in the whey to the percentage of fat contained in the milk.

5. The *quality* of the cheese produced from milk containing different percentages of fat.

6. The application of the results to different methods of dividing proceeds among patrons of cheese factories.

1. *Relation of weight of milk to the quantity of cheese produced from milk containing different percentages of fat.*

In making out reports of cheese factories, it is customary to give patrons a statement of the relation of the weight of milk delivered in a given time to the amount of cheese produced, in the form of the number of pounds of milk required to make a pound of cheese, together with the total pounds of cheese credited to each. The following table shows this relation in our experiments and also the pounds of cheese produced per 100 pounds of milk containing the different percentages of fat.

Group.	Percentage of fat.		Milk required to make 1 lb. of cheese.	Cheese produced per 100 lbs. of milk.	Cheese produced from 1 lb. of fat.	Per cent of fat in whey.
	Range.	Average.				
			lbs.	lbs.	lbs.	
I.	Below 3	2.85	11.644	8 587	2.01	0.182
II.	3.00 to 3.50	3.23	11.127	8.987	2.78	0.187
III.	3.55 to 4.00	3.85	10.027	9.972	2.59	0.200
IV.	4.05 to 4.50	4.198	9.435	10.597	2.52	0 222
V.	4.55 to 5.00	4.87	8.759	11.416	2.34	0.400
VI.	5.05 to 5.50	5.30	8.219	12.166	2.29	0.425
Av'rage.	.....	.....	10.399	9.615	2.66	

If we take the average decrease in the pounds of milk to make a pound of cheese for each increase of one-half of one per cent. of fat in the milk, we find it is about one-half a pound, except in the case of group 3 (3.50 to 4.20 per cent. fat), in which case the decrease in the pounds of milk required to make a pound of cheese, as compared with the previous group (3.0 to 3.5 per cent. fat) is about one pound of milk. To state it in another way—for every increase of one half of one per cent. of fat in the milk, the yield of cheese is increased about half a pound per 100 pounds of milk, though in group three the increase is nearly one pound over the previous group.

This extra yield of cheese in group three (3.55 to 4.0 per cent. fat) as compared with the previous group, is rather remarkable. The explanation is probably found in the fact that this group appears to have the greatest increase in the percentage of casein (when compared with the previous group) that is found in any of the groups. (See College Report for 1895, p. 22)

The decrease in the yield of cheese per pound of fat in the milk by groups, was about one-quarter of a pound in group II, as compared with group I; about two-tenths of a pound in group III, as compared with group II; 0.7 of a pound in group IV, as compared with

group III; .18 of a pound in group V, and .05 in group VI, compared with group V. The extreme difference in the yield of cheese per pound of fat in the milk was .71 pounds of cheese less in group VI (5.30 per cent. fat) as compared with the yield of cheese per pound of fat in the milk in group I (2.85 per cent. fat.) The decrease in the yield of cheese per pound of fat in the milk continues from poor to rich milk.

The average pounds of cheese produced from one pound of fat in the milk from all the experiments was 2.66.

3. *Relation of fat and casein to the cheese produced from milk with varying percentages of fat.*

In this case we are met at the outset with a somewhat difficult problem for cheesemakers, viz., how to determine the casein of milk. No short method, such as the Babcock test for determining fat, has yet been discovered for determining the casein of milk. Our chemist has analysed a great many of the samples here reported upon, and the results of casein determinations in milk containing varying percentages of fat, are given in the College report for 1895. To simplify matters, we have assumed that two represents the percentage of casein which is retained in the cheese. The amount above two per cent. of casein in milk, is nearly all, if not quite all, represented by the loss of fat and casein in the whey and in the pressing and curing of the cheese. If the percentage of casein increases to some extent with the fat, so does the loss of fat in the process of manufacture by all methods known at present.

The table also shows the relation of fat and casein to cheese by groups when using a sliding scale for the casein, and the relation when using the addend 2.3.

Table showing pounds of cheese per pound of fat and casein in milk with varying percentages of fat:

Addend representing casein.	Group I., per cent. fat—av. 2.85.	Group II., per cent. fat—av. 3.23.	Group III., per cent. fat—av. 3.85.	Group IV., per cent. fat—av. 4.198.	Group V., per cent. fat—av. 4.87.	Group VI., per cent. fat—av. 5.30.	Average of all
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
2	1.770	1.718	1.704	1.709	1.661	1.666	1.713
Sliding scale from 2.3 to 2.7	1.700	1.625	1.595	1.582	1.528	1.520	1.608
2.3.....	1.667	1.625	1.621	1.631	1.592	1.600	1.626

4. *Loss of fat in the whey from manufacturing into Cheddar cheese milk containing varying percentages of fat.*

These fat determinations in the whey were made by the Babcock method, and include, in most cases, the "white whey," after milling and pressing, which was mixed with the first whey dipped, and a sample of the whole was taken. We may conclude that the percentages in the table fairly represent the loss of fat in the manufacture of cheese by careful makers, except the "grease" which is sometimes found about the press or on the outside of the cheese. There was always the largest quantity of this "grease" from cheese made out of rich milk.

It will be noticed that the average percentage of fat in the whey increases with an increase of fat in the milk. If we subtract the pounds of cheese from the pounds of milk used to make the cheese in each group, we shall have, near enough for all practical purposes, the pounds of whey in each group. By multiplying the pounds of whey by the average percentage of fat in the whey, we have the loss of fat in each group. The total losses of fat in each group and the loss of fat in the whey per 100 pounds of cured cheese, are as follows:

Total pounds milk used.	Average per cent. fat in milk.	Total loss of fat in the whey.	Loss of fat in the whey per 100 lbs. cured cheese.
		lbs.	lbs.
5,700	2.85	9.48	1.93
33,000	3.23	56.16	1.89
34,200	3.85	61.57	1.80
12,000	4.198	23.81	1 87
600	4.87	2.12	3.10
600	5 30	2.23	3.06

5. *The relation of the fat in the milk to the quality of cheese made.*

All the cheese made in our experiments were scored at the College dairy by men who are recognized as expert judges. Most of the men who judged the cheese are investing their money in cheese nearly every day and ought to be able to judge of its money value.

We are indebted to the following gentlemen who have kindly assisted us in the judging: Messrs. A. F. MacLaren, Stratford, president of the Western Dairymen's Association of Ontario and judge of cheese at the World's Fair; R. M. Ballantyne, Stratford, son of the Hon. Thos. Ballantyne; A. T. Bell, Tavistock; T. B. Millar, Kincardine, inspector and instructor for the Western Dairymen's Association; G. J. Brill, Guelph.

The cheese were scored at about one month old. The November and December cheese of 1895 were scored several times, as reported under the results for those months. The average score for flavor, closeness, even color, and texture in the different groups is shown in the table. The score for finish is not given, as all were scored alike under this head.

Percentage fat in milk.	Flavor. (Max. 35.)	Closeness. (Max. 20.)	Even color. (Max. 15.)	Texture. (Max. 20.)	Average total score. (Max. 90.)
Under 3 %	30.28	18.11	14.71	17 00	80.10
3 to 3.50 %	30.49	17.78	14.00	17.15	79.42
3.55 to 4.0 %	30.86	17.92	14 05	17.36	80.19
4.05 to 4.50 %	30.90	18.10	13.87	17.19	83.06
*4.55 to 5.0 %	32.00	19.50	13.00	17.00	81.50
*5.05 to 5 50 %	32.00	19.50	13.50	16.50	81.50

* Only two cheese.

Two cheese made June 4th, 1894, were kept until June 25th, 1895, and were scored by Messrs. Brill and Bell. The cheese made out of 3.2 per cent. milk, scored seventy points out of 100, and the one made from 4.5 per cent. milk scored sixty-five points. The cheese were kept in a box in the basement of the dairy after they had been cured, and both were badly off in flavor, as the score shows. Three cheese made (one each month) in the months of September, October, and November, 1894, out of poor or medium milk, and three in the same months made out of rich milk, were kept in the basement of the dairy after curing, and were scored June 25th, 1895, by Messrs. Brill and Bell. The average score of the three cheese made from rich milk was 88.3. The average score of the others was 87.6. These cheese were examined again by Mr. Walker, of Guelph, on April 8th, 1895. He did not score them but he gave his judgment as follows: The cheese made from the rich milk in September was the better of the two. In the two October's he could not see much difference. The cheese made in November from poor or medium milk he pronounced the best cheese of the lot.

6. *Practical Application of the Two Years' Experiments to Methods of Dividing Proceeds Among Patrons of Cheese Factories.*

The experiments on the relation of fat in milk to the quanity and quality of cheese produced, have several scientific and practical bearings, but their most practical bearing at the present time is

upon the question of the best method of dividing the proceeds among patrons of cheese factories. It might be well to mention the three systems of apportioning dividends now in use among our cheese factories.

(1) The oldest is that of dividing according to the weight of milk delivered by each patron. This system is based on the principle that all samples of milk delivered by patrons are of equal value (per 100 pounds) for cheesemaking purposes. If a difference is admitted, it is considered so small that it is not worth considering. Our experiments go to show that there is a difference of two pounds of cheese per 100 pounds of milk between milk testing 4.2 per cent. fat and milk testing 2.85 per cent. fat. The difference in cheese-producing power of 100 pounds of 3.85 per cent. milk when compared with 100 pounds of 3.25 per cent. milk, is nearly one pound of cheese in favor of the richer milk. In other words, in those factories in which pooling according to the weight of milk is practised, there is taken from the patrons who send in milk averaging, say, 4.2 per cent. of fat, about one pound of their cheese, which is given to the patrons who send in 2 85 per cent milk, for each 100 pounds of milk delivered by both parties. In the case of 3.25 and 3 75 per cent. milk, about half a pound of cheese per 100 pounds of milk is taken from the richer milk and added to the poorer. If cheese nets eight cents a pound, the patrons with four per cent milk lose about eight cents per 100 pounds of milk by pooling with patrons delivering milk under three per cent., as they are credited with but *half* the increased cheese which their milk makes.

Having shown that this system is grossly unjust where the percentage of fat varies in the milk, it will be next in order to show what variation is to be found in milk delivered at our cheese factories. Messrs. A T. Bell, Tavistock, L. Patton, Oxford Mills, William Eager, Morrisburg, and the Secretary of the Elma factory, near Atwood in the Listowel district, have kindly furnished us with the highest, lowest, and average percentage of fat in milk delivered at their factories by months during the past year. Two of these factories are in Western Ontario and two in Eastern Ontario. The variation in the western factories is also given for 1894.

The widest difference in the percentage of fat in the milk delivered at the Oxford Mills factory was one per cent., which occurred in the months of June and October. The average difference for the six months between the highest and the lowest testing milk at this factory was .85 per cent.

Table showing variation in milk delivered by patrons of four factories in Ontario :

Name of factory.	Year.	Month.	Percentage of fat in milk delivered.			
			Highest.	Lowest.	Average of all.	Difference.
			per cent.	per cent.	per cent.	per cent.
Oxford Mills	1895	May	3.80	3.00	3.41	0.80
No. 13, Eager Combination	1895	"	3.54	3 28	3.39	0.26
Tavistock	1895	"	3.80	2.80	3.26	1 00
	1894	"	3.80	2.80	3.41	1 00
Elma	1895	"	4.00	3.20	3.35	0.80
	1894	"	3.75	2 94	3.35	0.81
Oxford Mills	1895	June	4.00	3.00	3 52	1.00
No. 13, Eager Combination	1895	"	3.60	3 34	3.49	0.26
Tavistock	1895	"	3.50	2.90	3.27	0.60
	1894	"	3 80	3.00	3.43	0.80
Elma	1895	"	3 60	3.05	3.34	0.55
	1894	"	4.00	3.13	3.44	0.87
Oxford Mills	1895	July	3.90	3.20	3.57	0.70
No. 13, Eager Combination	1895	"	3.50	3.30	3.41	0.20
Tavistock	1895	"	3.80	2 80	3.13	1.00
	1894	"	3.80	3.00	3.35	0.80
Elma	1895	"	3 70	3.00	3.33	0.70
	1894	"	3.77	3.06	3.48	0.71
Oxford Mills	1895	August.	4.00	3.10	3.63	0.90
No. 13, Eager Combination	1895	"	3 75	3.30	3.63	0.45
Tavistock	1895	"	3.80	3.00	3.31	0.80
	1894	"	4 00	3.00	3.45	1.00
Elma	1895	"	3.65	2.60	3 43	1.05
	1894	"	3.88	3.17	3.53	0.71
Oxford Mills	1895	Sept	4 10	3.40	3.78	0.70
No. 13, Eager Combination	1895	"	3.90	3.50	3.68	0.40
Tavistock	1895	"	4.00	2.90	3.46	1.10
	1894	"	4.50	3.00	3.70	1.50
Elma	1895	"	4.00	3.20	3.42	0.80
	1894	"	4.10	3 23	3.69	0.87
Oxford Mills	1895	Oct	4.40	3.40	3.86	1.00
No. 13, Eager Combination	1895	"	4.00	3.55	3.90	0.45
Tavistock	1895	"	4.90	2.80	3.84	2.10
	1894	"	4.80	3.30	3.89	1.50
Elma	1895	"	4.25	3.50	.....	0.75
	1894	"	4.40	3.35	3.87	1.05
No. 13, Eager Combination	1895	Nov	4.60	3.70	4 14	0.90
Tavistock	1894	"	5.20	2.60	3.85	2.60
Elma	1895	"	4.60	3.00	.....	1.10
	1894	"	4.65	3.60	4.03	1.05

No. 13 of the Eager Combination did not vary so much as the other three. The widest difference was .9 per cent. in the month of November. During the remainder of the season, the milk de-

livered by different patrons was very similar in the percentage of fat. The average difference for the year between the highest and the lowest testing milk was .41 per cent. for the seven months. Mr. Eager mentions as one of the advantages of testing, that it tends to produce a more even quality of milk delivered by each patron.

The variation in the per cent. of fat in the milk at the Tavistock factory was the widest of the four. The greatest difference occurred in the month of October, 1895, and in November, 1894. The difference between the highest and lowest percentage of fat in milk delivered by patrons was 2.1 and 2.6, respectively, for these two months. The average difference for the season of 1895 was 1.1, and for 1894 1.3 per cent.

At the Elma factory, where the monthly variation was from .55 to 1.5 per cent. of fat, the average difference for 1895 was .92, and for 1894 the average difference in the fat of milk delivered for the season was .82 per cent. between the highest and the lowest.

Assuming that the difference in the quality of the milk delivered at these four factories represents the average difference for the Province, we can see how unjust it is to pool or divide money according to the weight of milk delivered. The average of the highest testing milk for the four factories is 4.02; and the average of all the low testing milk is 3.13, or an average difference of .89 per cent. of fat. A difference of .89 per cent. of fat in the milk is equal to a difference of about one and a half pounds of cheese per 100 pounds of milk. When cheese nets eight cents per pound it makes the four per cent. milk worth twelve cents more per 100 pounds than the three per cent. milk. If these two men pool their milk together, the man with the richer milk loses six cents per 100 pounds on all milk pooled, as he is credited with but half the increased value of his milk. A loss of six cents per 100 pounds of milk is a loss of $3 on 5,000 pounds, or $30 on ten cows' milk for the season. A patron who sends in four per cent. milk to a factory, feeds, milks, and cares for about one cow out of the ten for the benefit of his three per cent. neighbor when pooling according to the weight of milk.

(2) The second system proposed, and adopted by a member of our cheese factories, is what is known as the "Butter Fat System," or "Relative Value Plan," or the "Test System." This system apportions dividends among patrons according to the weight of fat delivered, as determined by the Babcock test. The principle upon which it is based, is that milk is valuable for cheese-making in proportion to the butter-fat which it contains. For a time this system was quite popular, but owing to various causes, the chief of which are the expense and the lack of confidence in its justice, this system has been discarded by a number of factories. Omitting the questions of

expense, risk of improper testing, extra labor for maker and secretary, all of which are important factors in the minds of patrons, some felt that cheese is not made out of butter-fat alone, and that something else in the milk ought to be considered when deciding so important a matter as the reward for skill and labor in dairy farming. Practical cheese factory experience went to prove that the yield of cheese was not in exact proportion to the butter-fat contained in the milk. It was considered by many of the patrons that the *many* were being deprived of their rights for the benefit of the few who delivered very rich milk. The new system differed in principle from the old, chiefly in this, that it placed a premium on butter-fat, instead of on water and skim-milk. This was an improvement as to the point on which the premium should be placed; but the question still remained unsettled, as to whether it was just to place so great a premium on butter-fat for cheese-making. To illustrate: The average percentage of fat in the milk of Group IV. (4.05 to 4.55 per cent. fat) was practically 4.2. The pounds of cheese made in this Group was 10.6 per 100 pounds milk. Group II. (3 to 3.50 per cent. fat) averaged practically 3.25 per cent of fat, and produced nine pounds of cheese per 100 pounds of milk. 10.6 pounds at eight cents equals 84.8 cents. Nine pounds at eight cents equals seventy-two cents—a difference of 12.8 cents per 100 pounds of milk in favor of the richer milk. Now if we divide on the fat basis the account stands: 4.2 pounds fat at 21.048 cents per pound equals 88.4 cents; 3.25 pounds fat at 21.048 cents per pound equals 68.4 cents, or a difference of twenty cents in favor of the richer milk. The actual cheese value of 100 pounds of milk testing 3.25 per cent. of fat is seventy-two cents, as previously shown; but the butter-fat system proposes to take 3.6 cents (seventy-two cents minus 68.4 cents equals 3.6) per 100 from such milk and add it to the richer milk. Why is this done? Some argue that the richer milk mixed with the poorer milk makes a better quality of cheese, and therefore the patron furnishing such milk ought to receive more for it than its actual value, as determined by the quantity of cheese made. It is a question how far this is true with normal milk. A man who sends in 3.25 per cent. milk to a cheese factory and pools it with 4.2 per cent milk on the fat basis, loses, as previously shown, 3.6 cents per 100 pounds, or $1.80 per 5,000 pounds milk, and $18 in a season on ten cows (5,000 pounds per cow per season). He feeds, milks, and cares for about three-fifths of a cow for the benefit of his neighbors with rich milk.

(3) The third system proposed, and adopted by some of our factories is what may be called the "fat and casein system." Various methods of valuing the casein have been proposed. For reasons stated in a previous part of this Bulletin, the writer has adopted the addend *two* in connection with the fat to represent the casein. While it is not claimed that this system will give the *exact* amount of cheese

produced by all samples of milk, it comes near enough for all practical purposes, and is probably as near as any system of calculation will come. No formula or addend will give *exactly* the pounds of cheese which a given quantity and quality of milk will produce, for the reason that it is almost impossible to make cheese day after day with the same losses of fat, casein, etc., and of exactly the same composition. During the last two years we had thirty-one vats (300 pounds each), which tested 4.0 per cent. of butter fat. The pounds of cured cheese from each vat of 300 pounds of milk varied from 27.75 pounds to 33 5 pounds—a difference of 5.75 pounds of cheese from 300 pounds milk. We had also twenty-one vats testing 3.0 fat; and the pounds of cheese produced from 300 pounds of milk testing three per cent. fat ranged from 25.25 pounds to 28.25 pounds—a difference of three pounds of cheese from 300 pounds of milk. As wide variations as these will be found in all classes of milk, and these two are given in illustration of the difficulty met with in applying formulas to milk and fat in the calculation of the yield of cheese.

If we take the same groups (II. and IV.) as we did for fat alone, to illustrate the fat and casein method, and use the addend two for the casein, we shall find the account to stand as follows per 100 lbs. of milk: 4 2% fat + 2 = 6 2 pounds fat and casein at 13 694 cents per pound = 84 9 cents. The value of the cheese is 10.6 pounds at eight cents = 84 8 cents; 3 25% fat + 2 = 5.25 pounds fat casein per 100 pounds; 5.25 pounds fat and casein at 13.694 cents = 71.89 cents. The value of the cheese was nine pounds at eight cents, or 72 cents. This is very close to the exact value of the cheese made from both lots; but it gives a slight advantage to the richer milk and a corresponding disadvantage to the poorer milk. The same thing is noticed in the table that follows, in which it may be assumed that the average quality of milk in the six groups was furnished by six patrons, whose milk varied from 2.85 per cent. to 5.30 per cent of fat. The table shows the amount of money that would be credited to each patron by the three systems of dividing, and also the money value of the cheese made, at eight cents per pound This table covers two years' work, embracing 280 vats of milk (300 pounds each), or 86,100 pounds in all. From this milk were made 8,279 pounds of cured cheese. There were nineteen vats averaging 2.85 per cent. fat, 110 vats averaging 3.23 per cent. fat, 114 vats averaging 3.85 per cent. fat, forty vats averaging 4.198 per cent. fat, two vats averaging 4.87 per cent. fat, and two vats averaging 5.30 per cent. fat. We may consider that the table covers fairly well all variations in fat that are likely to be met with in factories and the conclusions may be considered fairly reliable, except in the case of the very rich milk—over 4.5 per cent. fat. The experiments in reference to this class of milk are not sufficient in number to warrant us in stating anything very definite concerning them. This milk, however, is not often met with in factory work.

It will be seen by the table that adding two per cent. to the fat readings places a slight discount on the milk averaging 2.85 and 3.23 per cent. of fat, and gives a small premium to the persons sending in average and richer milk. This premium is sufficient to induce patrons to send in good milk to the factory; it discourages tampering with the milk, and has all the advantages of the butter-fat system, without the disadvantage of placing too large a premium upon rich milk, to the disadvantage of medium and poorer milk. Milk with a low percentage of fat (under 3.25 per cent.) contributes a small amount of cheese for the benefit of the richer milk. The contribution is sufficient to induce the owners of such milk to furnish as high testing milk as possible; at the same time it does not unduly lower the rewards for present efforts.

We can recommend the fat and casein system (the casein being represented by the addend two) to patrons and managers of cheese factories, believing that it comes as near to justice as it is possible in factory work; and it is a simple method.

Table showing amount of money credited to different lots of milk with varying percentages of fat, according to three systems of distribution and according to the actual weight of cheese:

Lbs. Milk.	Average p. c. fat.	Lbs. cheese made.	Amounts of money (cheese 8c) credited by three systems and according to weight of cheese.				
			Wt. milk.	P.c. fat.	P. c. fat + 2	Wt. cheese	Diff'r'nce
			$ c.	$ c.	$ c.	$ c.	$ c.
5,700	2.85	489.50	43 83	34 60	37 89	39 16	−1 27
33,000	3.23	2,965 75	353 77	227 01	236 57	237 26	−0 69
34,200	3 85	3,410.50	263 00	250 42	274 24	272 84	+1 40
12,000	4.198	1,271.75	92 28	107 29	101 95	101 74	+0 21
600	4.87	68.50	4 61	6 22	5 65	5 48	+0 17
600	5.30	73.00	4 04	6 77	6 00	5 84	+0 16

In the two years' experiments, there were 38,700 pounds of milk testing less than 3.25 per cent. of fat. There were 47,400 pounds testing over 3.50 per cent. of fat. The milk under 3.25 per cent. of fat on the basis of the percentage of butter-fat plus two, contributes $1.96 to the richer milk.

Conclusions.

Our two years' experiments on the question of the relation of the fat in milk to the quantity and quality of cheese produced, seem to warrant the following conclusions:

1. That whole milk is not valuable for cheese making in proportion to its weight or volume, as 100 pounds of three per cent.

milk will make about one and a half pounds less cheese than 100 pounds of four per cent. milk.

2. That whole milk does not produce cheese exactly in proportion to the butter-fat contained in it, as one pound of fat in milk testing an average of 3.23 per cent., produced 2 78 pounds of cured cheese, while one pound of fat in milk testing an average of 4.2 per cent., produced an average of 2.52 pounds of cured cheese.

3. That the yield of cheese is fairly uniform in proportion to the fat and casein contained in the milk, when the latter is represented by adding two to the percentage of fat. This method gives results slightly lower than the actual yield of cheese, for milk testing under 3.25 per cent. of fat, and slightly above the actual yield, for milks testing over this percentage of fat

4. The percentage of fat in the whey was greater from rich milk than from poor milk, but the loss of fat per 100 pounds of cheese made, did not differ materially until milk with over 4.50 per cent. of fat was used.

5. That the relation of the fat of the milk to the quality of the cheese produced is the most difficult point of all to settle, as there is so much difference of opinion as to what constitutes "quality" in a cheese. It is difficult to get two judges to agree as to the number of points which cheese should be scored; and there does not seem to be a very definite relation between points scored and the market or money value. A cheese that would bring top price in one market might not do so in another. At present there is not enough discrimination made in cheese sold on the markets. All our cheese made at the College were sold for the same price each month.

6. That the cheese made from poor milk had a tendency to become harsh in texture, which may be partially remedied by using less salt and leaving more moisture in the cheese. Rich milk has a tendency to produce cheese somewhat "pasty" and "slippery" in character, which may be partially remedied by the use of extra salt and by cooking one or two degrees higher than usual. The flavor, closeness, even color, and texture of a cheese are somewhat dependent upon the fat present in the milk and retained in the cheese; but with normal milk there are a number of factors equally important in the manufacture and sale of Cheddar cheese. Among these are (1) what may be called good physical qualities in the milk, such as smell and taste; (2) skilful making; (3) differences in the tastes of judges and consumers.

7. That the percentage of fat in milk plus two is a fair basis upon which to distribute proceeds among patrons of cheese factories.

PART III.

Effects of Salt, Temperatures for Setting Milk, Acid at Milling Stage, and Temperature at Time of Putting Curd to Press.

Salt on Curds from Average Milk.

In addition to the experiments on the effect of salt on curds from average milk which were reported on page 50 of the College Report for 1895, three other experiments were made in November and December. The quantity ranged from two to four pounds of salt per 100 pounds of curd. The difference in the quality of the cheese made was not very marked, except in the case of the curd salted at the rate of four pounds of salt per 100 pounds of curd (December 18th—3.5 per cent. of fat in milk), which was pronounced a very "harsh" cheese by Mr. Bell on February 17th, 1896, and also by Mr. Ballantyne on February 21st. The flavor, closeness, and color were good, but the texture was scored down to thirteen by Mr. Bell and fifteen by Mr. Ballantyne out of a possible twenty. This cheese was again scored on April 7th, and still pronounced "harsh and short in texture" by Messrs. MacLaren and Ballantyne. It scored but twelve points out of twenty. We thought that the texture would likely improve if the cheese were kept, as it was good in every other quality. The large quantity of salt seems to have effectually stopped the "breaking down" process.

Table showing effect of salt on curd from milk containing an average per cent. of fat:

Date.	Lbs. milk.	Per cent. fat in milk.	Lbs. salt per 100 lbs. curd.	Lbs. cheese.		Score, max. 100
				Green.	Cured.	
Nov. 20th	600	3.70	2	33.00	31.50	93
			2¾	32.75	31.25	92
Dec. 4th	600	3.45	2¾	33.00	31.50	90
			3½	32.50	31.25	90
Dec. 18th	600	3.50	2¾	30.25	28.75	93
			4	30.50	28.75	90

Different Temperatures for adding Rennet to Milk.

With a normal working milk, most of our makers have settled on a temperature of eighty-six degrees for the milk when the rennet is added. To see the effect of other temperatures than those commonly used, seven experiments were made in November and December. The setting temperature varied from seventy to ninety-five degrees. The lower the temperature of the milk at setting, the longer the time required for curdling or coagulating. At a temperature of seventy degrees on November 12th, the time for curdling was one hour and sixteen minutes, while a vat of similar milk at eighty-six degrees coagulated in thirty-one minutes. At seventy-four degrees, the time was fifty-one minutes, as compared with twenty-eight minutes at eighty-seven degrees. Above eighty-six degrees, the time for coagulating was also shortened. At ninety degrees, coagulation was complete in thirty-one minutes, as compared with thirty-five minutes at eighty-six degrees. At ninety-five degrees, the time was twenty-two minutes, as compared with thirty-one minutes at eighty-six degrees.

These experiments indicate that above eighty-six degrees, up to ninety-five degrees, each increase of one degree in temperature in the milk will decrease the time required for coagulation by one minute. Below eighty-six degrees, down to seventy degrees, each degree of fall in temperature increases the time required for coagulation by about two minutes, other things being equal. The effect of setting-temperature on the time from setting to dipping seems to be that a temperature below eighty-six degrees requires a longer time before the curd is in a condition to "dip," as tested by the hot iron. Above eighty-six degrees, in the two experiments made, there was little difference in the time. The time from dipping to salting was practically the same at all the temperatures tried.

Perhaps the most important point of all was the extra loss of fat in the whey from setting at low temperatures. The loss was one half of one per cent. when set below eighty degrees. There was a corresponding decrease in the yield of cheese from these temperatures. The effect on the quality of cheese did not seem to be very marked. The two cheese made on December 16th, were kept until April 7th, when they were scored again by Messrs. MacLaren and Ballantyne. The cheese made from milk set at eighty-six degrees scored ninety-five points, and the one set at ninety-five degrees scored ninety-six points out of a possible one hundred. The cheese made from milk set at ninety-five degrees scored thirty-three for flavor, nineteen for closeness, fifteen for even color, and nineteen for texture. It lost two points in flavor and one point in both closeness and texture. This approaches

close to perfection for a cheese made in December which was scored when nearly four months old. Its mate set at eighty-six degrees was but one point behind. In the "remarks," when these cheese were made, it is noted, "The curds were of a tough, harsh nature." The cheese appear to have turned out all right.

Effect of Setting at Different Temperatures.

Date.	Lbs. milk.	Per cent. fat in milk.	Temperature for setting.	Minutes curdling.	Hours from setting to dipping.	Hours from dipping to salting.	Per cent. fat in whey.	Lbs. cheese.	Score.
			°		h. m.	h. m.			
November 4....	300	3.5	87	28	2 53	3 16	.2	30.25	90
	300	3.5	74	51	3 24	3 27	.5	28.25	91
" 12....	300	3.65	86	31	2 54	3 05	.2	30 25	87
	300	3.65	70	76	3 08	3 27	.5	28.25	89
" 19....	300	4.00	87	24	2 02	3 18	.25	31.75	89
	300	4.00	78	41	2 16	3 10	.4	31.00	88
" 26....	300	3.9	86	32	4 02	2 43	.25	30.75	90
	300	3.9	80	45	3 58	2 38	.30	30 75	89
December 2....	300	3.6	86	35	3 28	4 08	.20	30.25	88
	300	3.6	90	31	3 39	4 13	.20	30.50	90
" 9....	300	3.6	86	27	2 47	4 02	.20	30.75	89
	300	3.6	82	35	2 50	4 03	.20	30.75	92
" 16....	300	3.55	86	31	2 55	4 18	.25	30.00	94
	300	3.55	95	22	3 00	4 13	.25	30.50	93

Effect of Different Quantities of Rennet in Cheesemaking.

In addition to the experiments made in the spring on the effect of rennet in cheesemaking, three more were made in November and December. There is nothing special to report in these experiments, except that the extra rennet added, coagulated the milk in much less time than the ordinary amount did; but the time required for coagulation with a given quantity of rennet in these months was larger than in the spring, though the milk was of similar ripeness, as indicated by the rennet test. For instance, on April 6th and 9th, when the rennet test was twenty and eighteen seconds, the time required for coagulation was twenty-three minutes. On November 13th, with a rennet test of twenty-one seconds, the

time required for coagulation was thirty minutes. Four ounces of rennet per 1,000 pounds of milk were used in all cases. On April 13th, with a rennet test of twenty seconds, the time required for coagulation was fifteen minutes; and on December 11th, with a rennet test of nineteen seconds, the time for coagulation was twenty minutes, eight ounces of rennet per 1,000 pounds of milk being used in both cases.

The experiments are not numerous enough to establish a law for the time required in coagulation with different quantities of runnet; but taking the results so far, and averaging the time for spring and fall in cases where it is possible to do so, we obtain the following table:

Rate of Rennet, per 1,000 lbs. of milk.	Time of year.	Minutes coagulating.
1 oz. (one expt.)	Spring.	65 minutes.
2 ozs. " "	"	42 "
2½ " " "	"	40 "
3 " (av. 3 expts.)	"	33 "
3⅓ " " "	Fall	32.6 "
3½ " (av. 2 expts.)	Spring	27 "
4 " (av. 4 expts.)	Spring and Fall	26 "
4½ " (av. 2 expts.)	Spring	25.5 "
5 " (1 expt.)	"	20 "
6 " (av. 2 expts.)	Spring and Fall	18 "
7 " (1 expt.)	Spring	16 "
8 " (av. 2 expts.)	Spring and Fall	17.5 "
9 " (1 expt.)	Spring	13 "

The rennet test at setting in all these experiments, varied from eighteen to twenty-one seconds. Only one vat was set at eighteen seconds and one at twenty-one seconds. The remainder were set at nineteen and twenty seconds.

In all our experiments, an extra quantity of rennet added to the milk, caused the cheese to cure or ripen more quickly. To quote the words of one of the expert judges who scored a cheese made by adding a large quantity of rennet, and compared it with another cheese made on the same date under similar conditions, except in the quantity of rennet used: "There is a cheese (made with large amount of rennet) that will be rotten by the time this one (usual amount of rennet) is ripe." He did not know how the cheese were made at the time of judging them. The percentage of moisture was determined in these cheese, and there was little difference in them in this respect.

Table showing the effect of different quantities of rennet used in milk:

Date.	Rate of runnet per 1,000 lbs. milk.	Runnet test. Seconds.	Minutes Coagulating.	Time from setting to dipping.	Time from dipping to salting.	Lbs. cured cheese from 300 lbs. milk.	Per cent. fat in		Score.
							Whole milk.	Whey.	
	oz.			h. m.	h. m.				
Nov. 13th . . .	3⅓	21	34	3 35	3 48	30.25	34	.20	91
	4		30	3 28	3 55	30.25		.20	91
" 27th	3⅓	20	31	2 54	3 34	31.25	36	.20	93.5
	5		22	2 48	3 27	31.50		.20	93
Dec. 11th	3⅓	19	33	3 17	3 38	32 25	37	.20	92
	8		20	3 12	3 38	32.00		.20	92

Milling the Curd.

Between July 25th and Nov. 25th, 1895, twelve experiments were made to determine if possible the best stage at which to "mill" or "grind" curds. Six hundred pounds of milk were put into a vat, and the curd was kept together until it was time to mill one portion. The curd was then divided equally, and that part which was to be milled at an early stage was put through a Harris mill. The other half was delayed for some time, and afterwards milled with the same mill.

The test used for milling was the "hot iron test." It is usual to express this test in terms of so many inches or fractions of an inch of acid, though it is a question whether this test indicates acidity at all in the true sense of the term. In all probability it indicates a *condition* of the curd which may or may not be accompanied by corresponding degrees of acidity. We shall, however, continue to use the common terms for lack of something better. In these experiments, the "acid" at milling varied from "no acid" to two inches (A peculiar condition of the curd at times indicates "no acid" or "strings" at all, when tested with the hot iron test.) The table shows the results.

Effect of Milling at Different Stages of Acid.

Date.	Lbs. milk.	Per cent. fat.	Hours from dipping to milling.	Acid on hot iron at milling.	Hours from dipping to salting.	Per cent. fat in whey.	Lbs. cured cheese.	Score.
			h. m.	Length of strings.	h. m.			
July 25 ...	600	3.4	1 50	1½ inches	3 15	.20	27.75	87
			1 15	⅝ "	3 18	.20	27.75	88
Aug. 9 ...	600	3.5	1 43	1 "	3 15	.20	28	84
			1 15	¾ "	3 17	.20	27½	86
" 23 ...	600	3.4	1 30	⅝ "	3 30	.20	28.75	89
			1 45	½ "	3 32	.20	28.75	89
Sept. 6 ...	600	3.3	1 40	1 "	3 50	.15	28	88.5
			2 00	1¼ "	3 52	.15	28	90.5
" 20 ...	600	3.4	1 45	⅞ "	4 00	.20	28.25	88.5
			2 15	1¼ "	4 02	.20	28.50	89
Oct. 4 ...	600	3.5	1 45	¾ "	3 30	.15	30.75	88.5
			2 30	1 "	3 32	.15	30.75	85
" 18 ...	600	3.4	1 37	1¼ "	3 25	.20	29	91.5
			2 45	1½ "	3 30	.20	29.75	90
Nov. 1 ...	600	3.6	1 40	1⅛ "	3 20	.20	30.75	91
			3 00	1¼ "	3 22	.20	31.25	90
" 8 ...	600	3.5	1 30	¾ "	3 23	.40	28.25	87
			3 05	1¼ "	3 25	.40	28.25	85
" 11 ...	600	3.8	2 00	No acid.	4 13	.25	31.75	91
			4 00	"	4 15	.25	33.25	90
" 18 ...	600	3.8	2 00	1½ inches	4 00	.20	31.75	92
			3 55	2 "	4 02	.20	30.75	90
" 25 ...	600	3.75	1 05	1¼ "	3 20	.20	31.00	91
			1 55	1⅝ "	3 22	.20	31.00	90

It will be noticed that the length of time from dipping to salting, did not appear to be materially affected by the time or condition of milling within the range given. In other words, these curds were ready to salt in about the same length of time after dipping, whether milled early or late. The yield of cured cheese was very similar in all cases, except on Nov. 11th and 18th, in which cases on the 11th both curds showed "no acid" and on the 18th one curd showed two inches of acid at milling, and there was one pound less cheese from this curd.

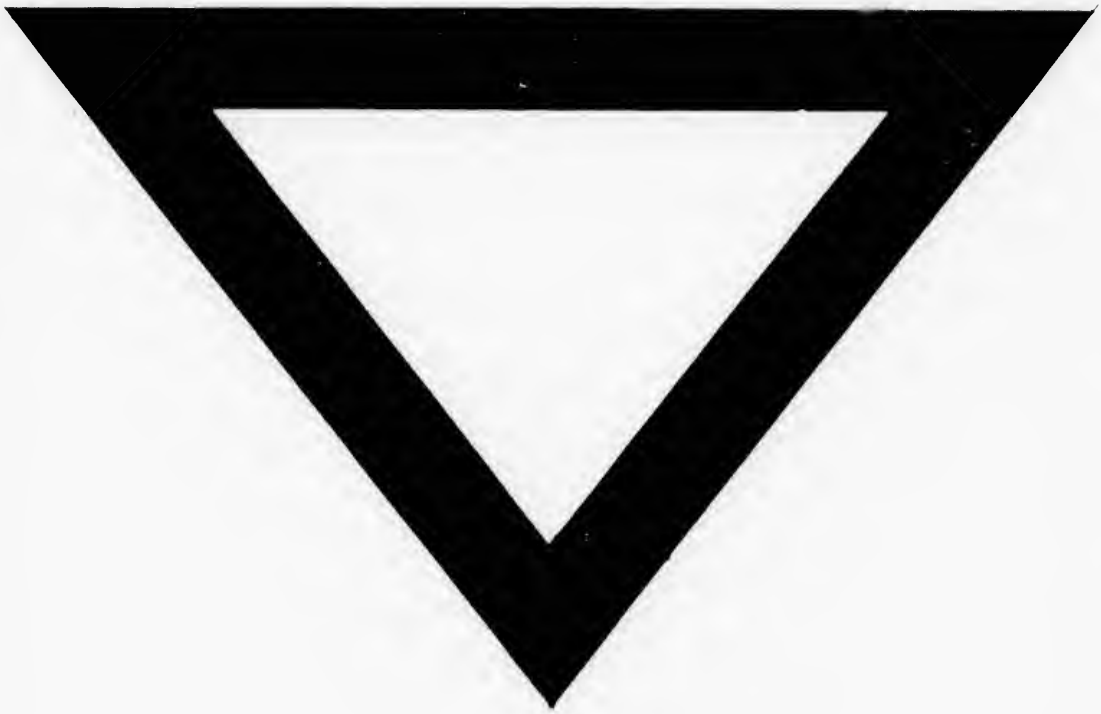
The quality of the cheese made on the same day was quite uniform throughout. The cheese made on Nov. 18th, 1895, were scored by Messrs. Brill and Millar, January 4th, 1896, and scored respectively ninety-two and ninety points, being two points in favor of early milling. The cheese made from the curd milled at two inches of acid, was pronounced "pasty." A few days afterwards these two cheese were scored at Woodstock (Dairy Convention), by Mr. A. F. MacLaren, and the score was ninety-five and ninety-six points, being one point in favor of the cheese milled at two inches of acid. Both cheese were scored alike in texture. These cheese were again scored on April 7th, and the score was 91.5 and 88.5, being three points in favor of early milling. The cheese milled at one and one-quarter inches of acid scored thirty two points in flavor, the same as it did at Woodstock. The cheese milled later scored thirty points, having lost three points since the last scoring. It had also become badly mottled in color, but whether this was due to the milling or not we are unable to say.

Effect of Different Temperatures of Curd when put to Press.

A temperature of eigthy degrees to eighty-five degrees at the time of putting the curd to press is usually considered to be about right. Above eighty-five degrees at this stage, it is considered that cheese are more liable to "huff;" and below eighty degrees, that there is more difficulty in getting a "close" cheese. As the table shows, in all the experiments quoted there was little or no complaint as to "open" cheese in a range of temperatures from sixty-six degrees to ninety-four degrees. Further experiments are needed to settle the point of the best temperature for putting curds to press. It would seem from these experiments that the temperature of the curd at the time it is put to press has not much to do with making the cheese "open."

Table Showing Effect of Temperature of Curd when put to Press.

Date.	Lbs. milk.	Per cent. fat in milk.	Lbs. cheese.		Temperature when put to press.	Scoring of cheese.					
			Green.	Cured.		Flavor.	Closeness.	Even color.	Texture.	Finish.	Total.
					Deg.						
Nov. 2	600	3.50	34.00	32.50	80	32	19	15	19	10	95
			34.25	32.75	66	32	20	15	19	10	96
" 30	600	3.50	31.00	29.50	82	31	19	14	19	10	93
			31.25	29.50	70	30	19	14	18	10	91
Dec. 3	600	3.80	33.00	31.75	80	32	19	13	15	10	89
			34.00	32.50	8	32	19	13	15	10	89
" 7	600	3.60	32.75	31.50	80	31	19	14	17	10	91
			33.50	32.23	70	31	19	14	17	10	91
" 10	600	3.60	33.75	32.25	82	32	19	14	17	10	92
			35.00	33.25	70	32	19	14	17	10	92
" 14	600	3.60	32.25	31.00	83	32	20	14	16	10	92
			31.50	30.25	94	32	19	14	16	10	91
" 17	600	3.55	32.00	30.50	81	30	18	13	15	10	86
			31.50	30.00	90	32	19	13	15	10	89

The cheese made Nov. 2nd and those made Dec. 17th, 1895, were kept until April 7th, during which time the November cheese were scored four times and the Decembers three times. The table of scoring shows the difference in these cheese from time to time. The two cheese made Dec. 17th were of a peculiar yellow and white color on April 7th, the cause of which we are unable to state. Of the two cheese made Nov. 2nd, put to press at eighty degrees and sixty-six degrees respectively, it will be noticed that the cheese put to press at eighty degrees remained a uniform quality until April 7th, while that put to press at sixty-six degrees deteriorated.

Date cheese were made.	Temperature put to press.	Names of Judges.	Date of scoring.	Scoring of the cheese.					
				Flavor.	Closeness.	Even color.	Texture.	Finish.	Total score.
Nov. 2 ...	80° F.	T. B. Millar and G. J. Brill.	Jan. 4, '96	32	19	15	19	10	95
		A. F. MacLaren.....	" 9, '96	32	18	14	18	10	92
		R. M. Ballantyne.....	Feb. 21, '96	30	19	15	19	10	93
		R. M. B and A. F. M	Apr. 7, '96	33	19	14	19	10	95
" 2	66° F.	T. B. M. and G. J. B.....	Jan. 4, '96	32	20	15	19	10	96
		A. F. M	" 9, '96	32	19	14	19	10	94
		R. M. B	Feb. 21, '96	28	19	15	19	10	91
		A. M. B. and A. F. M.....	Apr. 7, '96	27	19	14	19	10	89
Dec. 17	81° F.	A. T. Bell.....	Feb. 17, '96	30	18	13	15	10	86
		R. M. B	" 21, '96	30	19	14	18	10	91
		R. M. B. and A. F. M.....	Apr. 7, '96	27	18	8	16	10	79
" 17	90° F.	A. T. Bell.....	Feb. 17, '96	32	19	13	15	10	
		R. M. B	" 21, '96	32	19	14	18	10	
		R. M. B. and A. F. M.. ..	Apr. 7, '96	30	19	10	15	10